REMARKS

The Office Action dated October 27, 2003 has been carefully considered. Claims 1-23 and 33-35 are in this application.

The previously-presented claims 1-8, 10, 13, 15-18, 21, 33 and 35 were rejected under 35 U.S.C. § 103 as being obvious in view of previously cited U.S. Patent No. 6,156,273 to Regnier et al. ("Regnier et al."), in combination with U.S. Patent No. 6,294,063 to Becker et al. ("Becker et al."). Applicants submit that the teachings of this reference does not teach or suggest the invention defined by the present claims.

Applicants point out that the invention defined by the present claims does not use metal electrodes for trapping. Applicants submit that the Examiner is confusing arrays of obstacles used for separating by sieving, which are most often SiO obstacles, with traps of the present invention for dielectrophoresis. Applicants submit that all of the references cited by the Examiner use metallic electrodes for establishing a field between the metallic electrodes this field can be used for trapping near the metal electrodes. However, the fabricated, insulating, obstacles of the references cited are separately used for separation, for channels, for support posts, and the like. Applicants submit that the device of the present invention provides a dielectrophoretic trap by providing a dielectrophoric field to constrictions to narrow the field lines down as they pass between the constrictions thereby confining the dielectrophoretic field to a smaller cross-section in the gap between and providing a dielectrophoretic force, as shown in Fig. 1D and on page 12, line 26 through page 16, line 15. Accordingly, in order to achieve the narrowing effect of the field lines, the constrictions are formed of a material that the field lines cannot penetrate. Thus, the trapping of the present invention is created by confining the dielectrophoric field between two insulating constrictions not by a field established next to metallic electrodes. The present invention shapes the field by taking advantage of the fact that as electric fields are necked down between two insulating constrictions, the field gradient, where particles are trapped, is maximum at the narrowest point in the "neck." There is no teaching or

suggestion in any of the cited references that a dielectorphoretic force for trapping polarizable particles is created if the dielectrophoric field is confined in a smaller cross section.

Regnier et al. discloses a separation column including a number of side-by-side monolith support structures 14 defining a series of interconnected microchannels 12. The interconnected microchannels sequentially split and merge. The walls of the support structures comprise interactive surfaces for effecting chromatographic separation of an analyte. The coating can include anionic groups, cationic groups, hydrocarbon groups, chelation groups, antibodies and antigens. The interaction of the sample with the treated surfaces provides separation of the sample. The separation column can be driven by electroosmotic flow due to application of an electric field. An electric field 76 is applied to the channels by electrodes for providing flow of a liquid inside the channels in the direction of the arrows shown in Fig. 4a (col. 9, line 43 through col. 10, line 18). The ratio of the overall surface area to the overall value of the channels (A/V ratio) is maximized by making the channels as long as possible. The long narrow channels minimize the diagonal field-like effect.

In contrast to the invention defined by the present claims, Regnier et al. do not teach or suggest a microfluidic device for trapping polarizable particles by passing polarizable particles in the vicinity of a substrate bearing a plurality of constrictions each separated by a gap and applying a dielectrophoric field to the substrate in order to trap the polarizable particles in the gap by a dielectrophoretic force determined by confining the applied dielectrophoretic field to a smaller cross-section in the gap between the constrictions. To the contrary, Regnier et al. teach flow of a sample through interconnected microchannels in which the flow can be driven by application of an electric field from metal electrodes. Furthermore, any trapping of the particles in Regnier et al. are trapped by fields created near the metal electrodes. There is no teaching or suggestion in Regnier et al. that a dielectrophoric field can be applied to <u>trap</u> polarizable particles in a gap between constrictions by confining the dielectrophoretic field to a smaller cross section in the gap between the constrictions to provide a dielectorphoretic force. Rather, Regnier et al.

teach away from the present invention by teaching coating of the walls with cationic groups, anionic groups, hydrocarbon groups, chelation groups, antibodies and antigens for effecting a specific analyte to be immobilized or entrapped in the channels.

Further, the Examiner cites that "AC Electrokinetics: Applicants for Nanotechnology" that was published 30 November 1999 online at http://www.foresight.org/Conferences/MNT/Papers/Hughes/index.html. as evidence that the apparatus of Regnier, et al. may be used for trapping as well as separating particles." Hughes teaches an electrode array formed of gold or a similar conductor. Thus, metal electrodes can be used for trapping particles. However, Regnier et al. and Hughes do teach or suggest trapping of particles by confining the dielectrophoric field between two insulating constrictions not by a field established next to metallic electrodes. Accordingly, Regnier et al. do not teach or suggest the use of a dielectrophoric field to trap polarizable particles by confining the dielectrophoric field to a smaller cross section in the gap.

Becker et al. teach a method and apparatus for microfluidic processing in which a material is compartmentalized to form a packet. A programmable manipulative force uses dielectrophoretic and electrophoretic forces for moving the packets along a chosen path. In contrast to the invention defined by the present claims, Becker et al. do not teach or suggest trapping polarizable particles in a gap between constrictions with a dielectrophoretic force determined by confining the dielectrophoretic field to a smaller cross-section in the gap between the constrictions. Rather, Becker et al. teach movement of packets with an array of driving electrodes. Moreover, Becker et al. do not teach or suggest trapping a particle with a dielectrophoretic force determined by confining the dielectrophoric field to a smaller cross-section in the gap between the constrictions. Accordingly, the invention defined by the present claims is not obvious in view of Regnier et al. in combination with Becker et al.

Claim 23 was rejected under 35 U.S.C. § 103 as obvious in view of Regnier et al. in combination with Becker et al. and U.S. Patent No. 6,358,387 to Kopf-Sill et al. ("Kopf-Sill

et al.").

Kopf-Sill et al. disclose an illumination and detection system for use in illuminating a plurality of samples in a plurality of microchannels. An excitation beam having two or more excitation wavelengths is focused onto the plurality of microchannels to simultaneously excite the samples in at least two of the channels so as to cause the samples to emit radiation. Detection optics direct the radiation with a specific radiation wavelength range to a corresponding detector. Positive pressure sources are coupled to various reagent supply reservoirs to drive material through channels of the device.

In contrast to the invention defined by the present claims, Kopf-Sill et al. do not teach or suggest a microfluidic device for trapping polarizable particles by passing polarizable particles in the vicinity of a substrate bearing a plurality of constrictions each separated by a gap and applying a dielectrophoric field to the substrate in order to trap the polarizable particles in the gap by a dielectrophoretic force determined by confining the applied dielectrophoretic field to a smaller cross-section in the gap between the constrictions to provide a frame for trapping particles. Rather, Kopf-Sill et al., similar to Regnier et al. and Becker et al. described above, teach microchannels, but do not teach or suggest confining a dielectrophoretic filed between a smaller cross section in a gap between the constrictions. Thus, Kopf-Sill et al. do not cure the deficiencies of Regnier et al. and Becker et al. described above. Accordingly, the invention defined by the present claims is not obvious in view of Regnier et al. and Becker et al. in combination with Kopf-Sill et al. since none of the references teach or suggest trapping of a polarizable particle in a gap between constrictions by confining of a dielectrophoric field to a smaller cross section in a gap between the constrictions.

Claims 5-7 and 9 were rejected under 35 U.S.C. § 103 as being obvious in view of Regnier et al. and Becker et al. in combination with U.S. Patent No. 6,117,460 to Walters et al.

Walters et al. disclose a method of treating material with electrical fields and an added treating substance. A plurality of electrodes is arrayed around the material to be treated.

Electrical pulses are applied in a computer-controlled sequence of at least three non-sinusoidal electrical pulses to electrodes in the array of electrodes, the electrical pulses are applied to a cuvette.

In contrast to the invention defined by the present claims, Walters et al. do not teach or suggest a microfluidic device for trapping polarizable particles by passing polarizable particles in the vicinity of a substrate bearing a plurality of constrictions each separated by a gap and applying a dielectrophoric field in order to trap the polarizable particles in the gap by a dielectrophoretic force determined by confining the applied dielectrophoretic field to a smaller cross-section in the gap between the constrictions. Rather, Walters et al. teach the use of metal electrodes with the device to treat biological cells in order to induce pore formation within the cells. There is no teaching or suggestion of trapping polarizable particles upon application of a dielectrophoric fluid to a substrate, as defined by the present claims. Rather, Walters et al. teach the use of a plurality of electrodes around a material to be treated. Applicants submit that the use of metal electrodes in a microenvironment has the disadvantage of evolving a gas which renders the microenvironment unusable. In contrast to the present invention, electrodes are positioned on opposite edges of a substrate but are not in the microenvironment of the constrictions and do not have the disadvantage of Walters et al. of using metal electrodes in a microenvironment. Accordingly, the invention defined by the present claims is not obvious in view of Regnier et al. and Becker at al. in combination with Walters et al. since none of the references teach or suggest trapping of a polarizable particle in a gap between constriction by confining of a dielectrophoric field to a smaller cross section in a gap between the constrictions.

Claims 11 and 12 were rejected under 35 U.S.C. § 103 as being obvious in view of Regnier et al. and Becker et al. in combination with U.S. Patent No. 5,427,663 to Austin et al. ("Austin et al.").

Austin et al. disclose an electrophoresis device for sorting microstructures in a fluid medium. A substrate includes a receptacle having first and second ends and a pair of upstanding

opposed side walls. A sifting means comprises a plurality of obstacles. An electric field induces the microstructures to migrate through the medium (Col. 10, lines 20-30). As the molecules migrate through the array of obstacles, the molecules can become hooked by the obstacles (Col. 6, lines 9-60 and Figs. 6-7).

In contrast to the invention defined by the present claims, Austin et al. do not teach or suggest a microfluidic device for trapping polarizable particles by passing polarizable particles in the vicinity of a substrate bearing a plurality of constrictions each separated by a gap and applying a dielectrophoric field to the substrate in order to trap the polarizable particles in the gap by a dielectrophoretic force determined by confining the applied dielectrophoretic field to a smaller cross-section in the gap between the constrictions. Moreover, Austin et al. do not teach or suggest that a dielectrophoric field can be used to trap particles in a gap between constrictions instead of the object itself. As described on page 7, lines 4-6 of the application, the present invention allows particles to be trapped and thereafter released upon no longer applying the dielectrophoric field. In contrast, the particles of Austin et al. are attached to the obstacles and are not released by removal of the dielectrophoric field. Further, in Austin et al. an electric field is used to move microparticles through the microstructure. However, there is no teaching or suggestion in Austin et al. that a dielectrophoric field is applied for trapping of the particles by a dielectrophoretic force determined by confining the applied dielectrophoretic field to a smaller cross-section in the gap between the constrictions. Accordingly, the invention defined by the present claims is not obvious in view of Regnier et al. in combination with Austin et al. since neither reference teach or suggest trapping of a polarizable particle in a gap between constriction by application of a dielectrophoric field.

Claim 14 was rejected as obvious in view of Regnier et al., Becker et al., Austin et al., or U.S. Patent No. 6,368,871 to Christel et al. ("Christel et al."). In the present invention the shape and cross section of the constriction can be used to adjust the dielectrophoric (DEP) force (page 12, line 30 through page 13, line 3). The trapezoidal shape with angled edges directs the

polarizable particles into the gap between constrictions (page 11, lines 14-16). There is no teaching or suggestion in Austin et al. for varying the shape of the obstacles to adjust the DEP force or promote flow into a gap between obstacles.

Christel et al. teaches nonplanar microstructures for manipulation of fluid samples. The internal microstructure includes a network of channels. First and second channels can converge into a common channel to provide a contact region for the fluid streams.

In contrast, to the invention defined by the present claims, Christel et al. do not teach or suggest trapping polarizable particles in a gap between constrictions with a dielectrophoretic force determined by confining the dielectrophoretic field to a smaller cross-section in the gap between constrictions. Instead, Christel et al. teach microchannels, but do not teach or suggest a plurality of constrictions and trapping particles in a gap between the constrictions. Thus, Christel et al. do not cure the deficiencies of Regnier et al. and Becker et al. described above. Accordingly, the invention defined by the present claims is not obvious in view of Regnier et al. and Becker et al. in combination with Christel et al. since none of the references teach or suggest trapping a polarizable particle in a gap between constrictions by confining of a dielectrophoric field to a smaller cross section in a gap between the constrictions.

Claims 19-22 were rejected under 35 U.S.C. § 103 as obvious in view of Regnier et al. in combination with U.S. Patent No. 4,344,325 to Quake et al. ("Quake et al.").

Quake et al. disclose a microfabricated device including a main channel with a sample inlet, a detection region and adjacent and downstream of the detection region a branch point discrimination region. An optical signal such as fluorescence from a reporter molecule associated with the polynucleotide molecule can be used to determine polynucleotide size or to direct selected polynucleotides into one or more channels of the device.

In contrast to the invention defined by the present claims, Quake et al. does not teach or suggest a microfluidic device for trapping polarizable particles by passing polarizable particles in the vicinity of a substrate bearing a plurality of constrictions each separated by a gap and

applying a dielectrophoric field to the substrate in order to trap the polarizable particles in the gap by a dielectrophoretic force determined by confining the applied dielectrophoretic field to a smaller cross-section in the gap between the constrictions. Quake et al., similar to Regnier et al. and Becker et al., teach a microchannel arrangement. However, Quake et al. do not teach or suggest a plurality of constrictions and trapping of particles within a gap between the constrictions by narrowing the a dielectrophoric field between the constrictions. Accordingly, the invention defined by the present claims is not obvious in view of Regnier et al. and Becker et al. in combination with Quake et al. since neither reference teach or suggest trapping of a polarizable particle in a gap between constrictions by confining of a dielectrophoric field to a smaller cross section in a gap between the constrictions.

In view of the foregoing, Applicants submit that all pending claims are in condition for allowance and request that all claims be allowed. The Examiner is invited to contact the undersigned should she believe that this would expedite prosecution of this application. It is believed that no fee is required. The Commissioner is authorized to charge any deficiency or credit any overpayment to Deposit Account No. 13-2165.

Respectfully submitted,

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Diane Dunn McKay
Reg. No. 34,586
Attorney for Applicant

MATHEWS, COLLINS, SHEPHERD & McKAY, P.A.
100 Thanet Circle, Suite 306
Princeton, NJ 08540
Tel: 609 924 8555
Fax: 609 924 3036